ENERGY METABOLISM
Energy content of food materials is measured in calories.

One calorie is the heat required to rise the temperature of 1 g of water through 1°C.

Energy content is expressed in Kilocalories (Kcal). Which is equal to 1000 calories.

One Kilocalorie = 4.2 Kilojoules (KJ).

The maximum available energy contained in a food can be measured by having it in an atmosphere of oxygen in a bomb calorimeter.

Calorific value or energy density (energy yield/unit weight of food).
Energy yield from nutrients

<table>
<thead>
<tr>
<th>NUTRIENT</th>
<th>CALORIFIC VALUE Kcal/g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrates</td>
<td>4</td>
</tr>
<tr>
<td>Fats</td>
<td>9</td>
</tr>
<tr>
<td>Proteins</td>
<td>4</td>
</tr>
<tr>
<td>Alcohols</td>
<td>7</td>
</tr>
</tbody>
</table>
**RESPIRATORY QUOTIENT (RQ)**

- Respiratory quotient is defined as the ratio of volume of CO\(_2\) produced to the oxygen consumed.

- RQ of carbohydrates = 1
- RQ of fats = 0.7
- RQ of proteins = 0.8
- RQ of mixed diet = 0.7-1.

When the rate of utilization of fat increases in relation to carbohydrates, RQ falls. This happens in diabetes mellitus.

RQ is lowered when ketolysis is very active.
Energy requirement of normal person

- While calculating energy requirement we have to consider the energy yield for:
  1. Maintenance of BMR
  2. SDA or thermogenic effect of food
  3. Extra energy expenditure for physical activity.
BASAL METABOLIC RATE
DEFINED AS THE ENERGY EXPENDITURE AT REST, AWAKE, IN A THERMONEUTRAL (WARM) ENVIRONMENT 8-12 HOURS AFTER THE LAST MEAL & 8-12 HOURS AFTER ANY SIGNIFICANT PHYSICAL ACTIVITY

IT IS THE ENERGY EXPENDITURE NECESSARY TO MAINTAIN BASIC PHYSIOLOGIC FUNCTIONS SUCH AS

1. THE ACTIVITY OF THE HEART
2. RESPIRATION
3. CONDUCTION OF NERVE IMPULSE
4. ION TRANSPORT ACROSS MEMBRANES
5. REABSORPTION IN KIDNEY
6. METABOLIC ACTIVITY

MEASUREMENT
1. DIRECTLY BY CALORIMETER BY MEASURING THE HEAT DISSIPATED UNDER BASAL CONDITION
2. INDIRECTLY BY MEASURING OXYGEN CONSUMPTION – CLOSED CIRCUIT METHOD – ATAWATER-BENEDICT-ROTH BMR APPARATUS (subject breaths in oxygen CO2 produced is absorbed in soda lime. Subject is asked to breath through a mouth piece for 6 min. oxygen consumption volume is recorded, & calculated for 24hr)
FACTORS AFFECTING BMR

IN VARIABLE FACTORS
1. GENDER / SEX
2. AGE

VARIABLE FACTORS
1. NUTRITIONAL STATE
2. BODY SURFACE AREA
3. BODY COMPOSITION
4. HORMONAL STATE – THYROID HORMONE
5. ENVIRONMENTAL TEMPERATURE – COLD
6. EXERCISE – INCREASES
7. FEVER – 12% INCREASE / °C
NORMAL VALUES
MALES : 34 - 37 KCAL/SQM/HOUR
FEMALES: 30 - 35 KCAL/SQM/HOUR

CLINICAL APPLICATION
1. DIAGNOSTIC TOOL FOR THYROID DISORDER
2. CALCULATING CALORIC REQUIREMENT
3. TO OBSERVE THE EFFECT OF FOOD AND DRUGS
SPECIFIC DYNAMIC ACTION

ALSO KNOWN AS THERMOGENIC EFFECT OF FOOD- REFERING TO INCREASED HEAT PRODUCTION FOLLOWING INTAKE OF FOOD.

IT IS THE ENERGY EXPENDED IN THE DIGESTION, ABSORPTION, STORAGE AND SUBSEQUENT PROCESSING OF FOOD.

THE ENERGY IS TRAPPED FROM THE PREVIOUSLY AVAILABLE ENERGY SO THAT THE ACTUAL ENERGY FROM THE FOOD IS LESSER THAN THAT OF THEORETICAL CALCULATION. SDA CAN BE CONSIDERED AS THE ACTIVATION ENERGY NEEDED FOR A CHEMICAL REACTION. THIS IS TO BE SUPPLIED INITIALLY
FOR 250G OF CARBOHYDRATE 250 X 4 = 1000 KCAL IS PRODUCED.
ABOUT 10% ENERGY THAT IS 100KCAL IS DRAWN FROM THE RESERVE FOOD OF THE BODY.
THE NET GAIN IS 1000-100 = 900 KCAL
IF THE PERSON WANTS TO GET 1000 KCAL HE SHOULD TAKE FOOD WORTH 1100KCAL.
ADDITIONAL CALORIES EQUIVALENT TO SDA TO BE ADDED IN THE DIET.
PROTEIN – 30%
LIPID - 15 %
CARBOHYDRATE – 5%
FOR A MIXED DIET, EXTRA 10% SHOULD BE ADDED DUE TO LOSS OF ENERGY AS SDA
PHYSICAL ACTIVITY

THE ENERGY REQUIREMENT DEPENDS ON OCCUPATION

THE ACTIVITY LEVEL MAY BE DIVIDED INTO

1. SEDENTARY
2. MODERATE &
3. HEAVY

ADDITIONAL CALORIES ARE TO BE ADDED FOR EACH CATEGORY

FOR SEDENTARY WORK ADD 30% OF BMR
FOR MODERATE WORK ADD 40% OF BMR
FOR HEAVY WORK ADD 50% OF BMR

ENERGY REQUIREMENT DURING PREGNANCY +300KCAL/DAY
LACTATION - +500KCAL/DAY

IN ADDITION TO BASIC REQUIREMENT
CALCULATION FOR ENERGY REQUIREMENT
FOR A 55 KG PERSON, DOING
MODERATE WORK

FOR BMR = 24 X 55KG = 1320 KCAL
+ FOR ACTIVITY = 40% OF BMR = 528 KCAL
SUBTOTAL = 1320 + 528 = 1848 KCAL
+ NEED FOR SDA = 1848 X 10% = 184 KCAL
TOTAL = 1848 + 184 = 2032 KCAL
ROUNDED TO NEAREST = 2050 KCAL
MULTIPLE OF 50
Dietary fiber

UNAVAILABLE/INDIGESTIBLE CARBOHYDRATE IN THE DIET
Maintains normal gut motility
Fibre rich diet improves bowel motility, prevents constipation, lowers cholesterol levels & improves glucose tolerance

- Cellulose
- Hemicelluloses
- Lignin
- Pectin
GLYCEMIC INDEX (GI)

- Ratio of the area under the curve (GTT) of a particular diet with a reference meal (50g glucose)
- Lower glyemic index foods are good for diabetic patients

- Potato Chips - 80-90
- Bread/Polished White Rice - 70-79
- Bananas/Parboiled Rice - 60-69
- Legumes/Milk/Peanuts - 35-40
PROTEIN ENERGY MALNUTRITION (PEM)
PROTEIN ENERGY MALNUTRITION (PEM)

Most widespread nutritional problem – in world
Mainly in developing countries
Predominantly affects children
Prevalence – 20 – 50% depending upon
Socio-economic status
TYPES OF MALNUTRITION

- Marasmus
- Kwashiorkor
MARASMUS

- Continued severe deficiency of both dietary energy and protein.

- Primary calorie deficiency

- Secondary protein deficiency
KWASHIORKOR

Isolated deficiency of protein along with adequate calorie intake.
### COMPARISON BETWEEN MARASMUS AND KWASHIORKOR

<table>
<thead>
<tr>
<th></th>
<th>Marasmus</th>
<th>Kwashiorkor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age of onset</strong></td>
<td>Below one year</td>
<td>1 – 5 year</td>
</tr>
<tr>
<td><strong>Deficiency of</strong></td>
<td>Calorie + Protein</td>
<td>Protein</td>
</tr>
<tr>
<td><strong>Cause</strong></td>
<td>Early weaning and repeated infection</td>
<td>Starchy diet after weaning. Precipitated by an acute infection.</td>
</tr>
<tr>
<td></td>
<td>Marasmus</td>
<td>Kwashiorkor</td>
</tr>
<tr>
<td>---------------------</td>
<td>----------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Serum Albumin</td>
<td>2-3 g/dl</td>
<td>&lt;2 g /dl</td>
</tr>
<tr>
<td>Edema</td>
<td>Absent</td>
<td>Present</td>
</tr>
<tr>
<td>Fatty liver</td>
<td>Absent</td>
<td>Present</td>
</tr>
<tr>
<td>Skin</td>
<td>Dry &amp; atrophic</td>
<td>Crazy pavement dermatitis</td>
</tr>
<tr>
<td>Hair</td>
<td>No characteristic change</td>
<td>Sparse, soft and thin hair, Curls maybe lost</td>
</tr>
<tr>
<td></td>
<td>Marasmus</td>
<td>Kwashiorkor</td>
</tr>
<tr>
<td>----------------------</td>
<td>----------</td>
<td>-------------</td>
</tr>
<tr>
<td>Growth retardation</td>
<td>Marked</td>
<td>Present</td>
</tr>
<tr>
<td>Attitude</td>
<td>Irritable</td>
<td>Lethargic</td>
</tr>
<tr>
<td>Appetite</td>
<td>Normal</td>
<td>Anorexia</td>
</tr>
<tr>
<td></td>
<td>Marasmus</td>
<td>Kwashiorkor</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Serum Cortisol</td>
<td>Increased</td>
<td>Decreased</td>
</tr>
<tr>
<td>Serum Insulin</td>
<td>Low</td>
<td>Maintained</td>
</tr>
<tr>
<td>Muscle wasting</td>
<td>Severe</td>
<td>Absent or mild</td>
</tr>
<tr>
<td>Body Fat</td>
<td>Absent</td>
<td>Diminished</td>
</tr>
</tbody>
</table>
KWASHIORKOR
MARASMUS
TREATMENT

Diet – 150 – 200 kcal / kg
3 – 4 g of protein / kg

3 parts vegetable protein and 1 part of milk protein.